



Extending NASA's Long-Term Data Records of SO₂ and NO₂ with SNPP/OMPS

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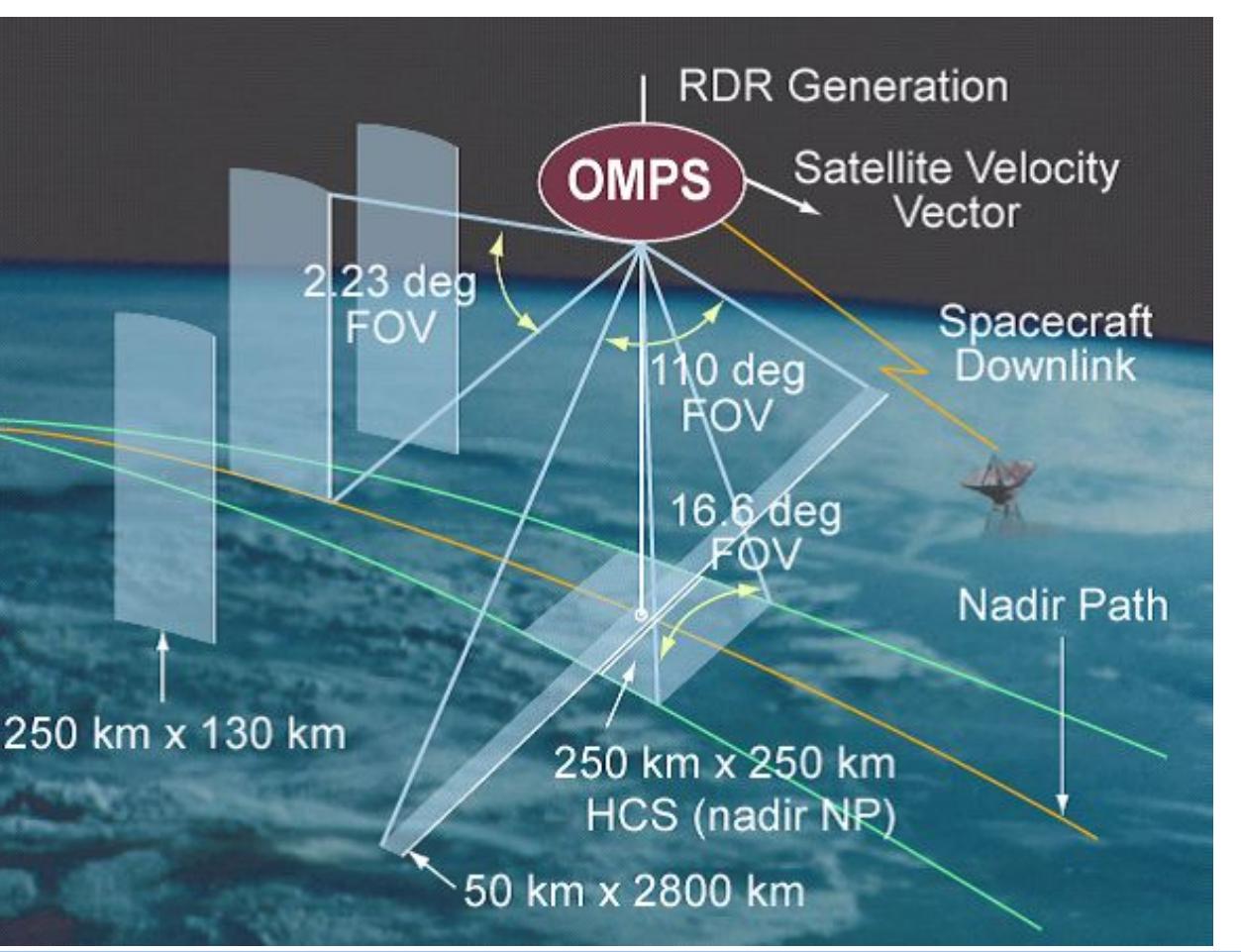
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Introduction

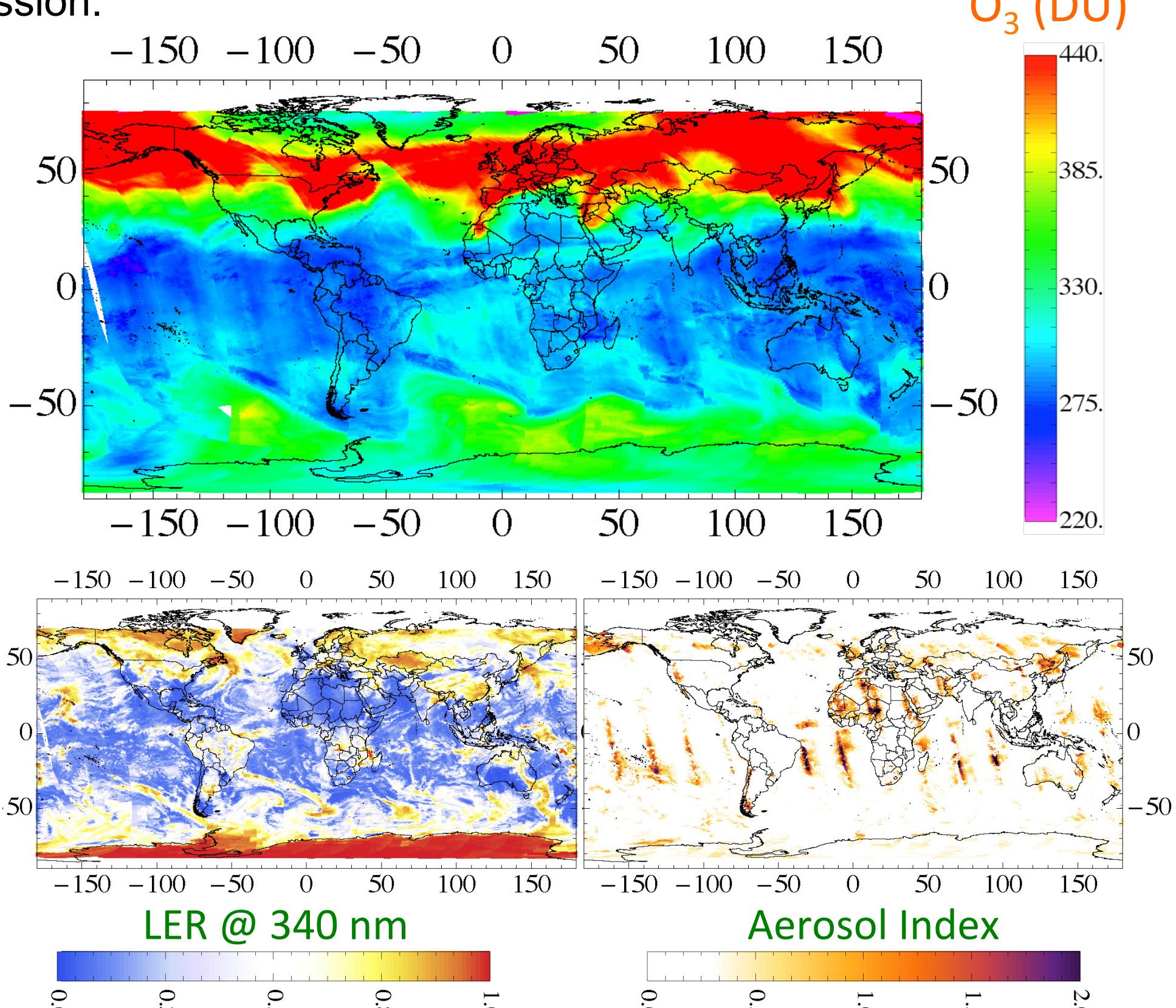
The Nadir Mapper is part of the Ozone Mapping and Profiler Suite (OMPS) that is flying onboard the Suomi-NPP satellite – first of the US Joint Polar Satellite System (JPSS). Two more JPSS satellites, with similar payloads are planned.



Nadir Mapper
Nadir Resolution:
50 km x 50 km
Swath 50 km x 2800 km
Spectral Range:
300 – 380 nm
Sampling Rate:
2.4 pixel per FWHM
or ~ 0.42 nm per pixel
Spectral Resolution:
FWHM ≈ 1 nm

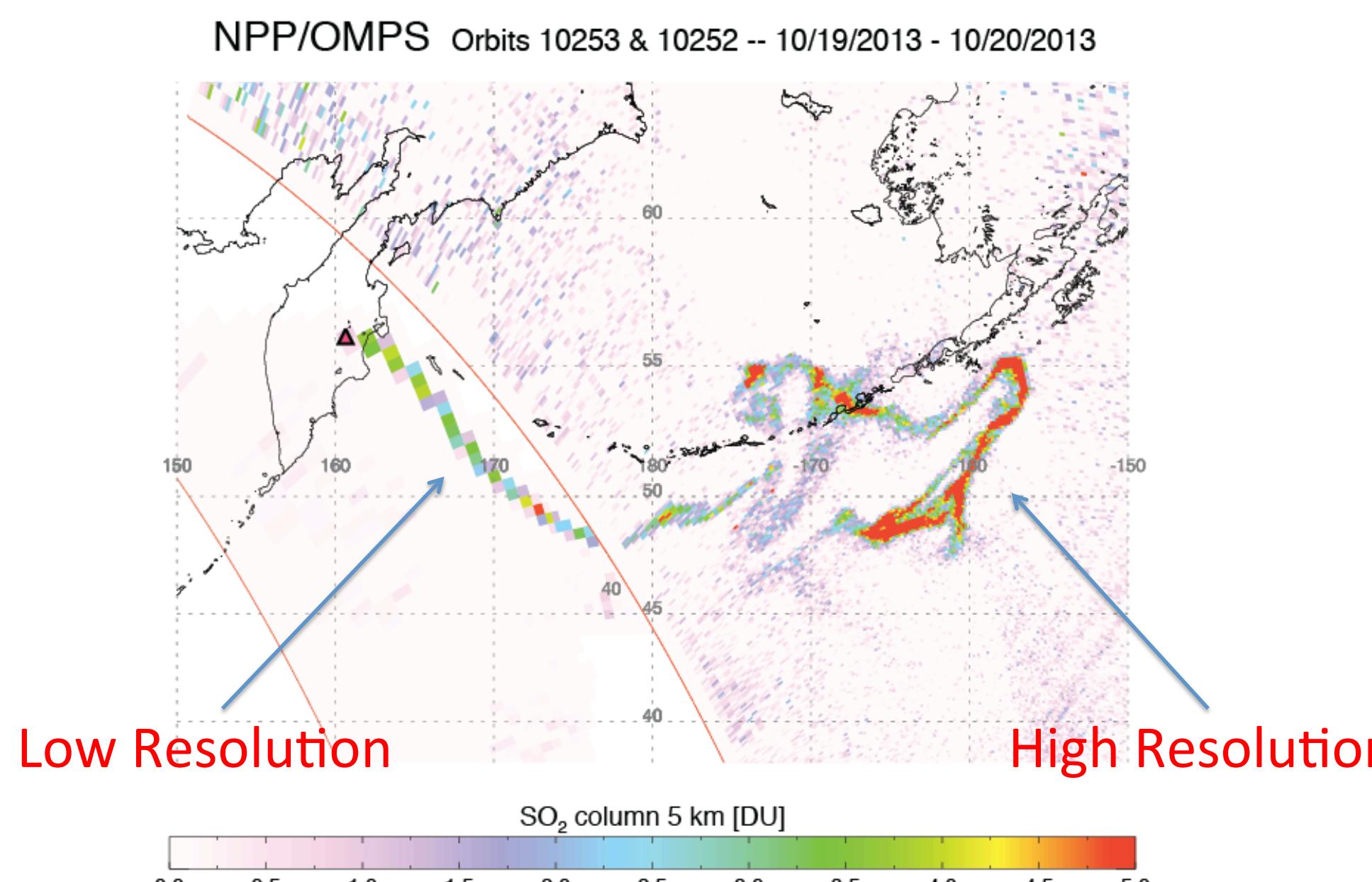
Primary OMPS Measurements

OMPS data continues the long-term satellite ozone, UV reflectivity, and UV aerosol index records started in 1978 with NASA's TOMS mission.



Monitoring of Volcanic Plumes

OMPS also provides sulfur dioxide data for quantifying volcanic SO₂ emissions and for aviation hazard mitigation.



Next OMPS NM on JPSS-1 and JPSS-2 will have higher spatial resolution, similar to that periodically taken by SNPP/OMPS currently. The above example demonstrate the higher resolution capabilities of the sensor.

Advanced Retrieval for Sensitive Tropospheric Measurement

The OMPS-NM is designed to monitor global total ozone columns. However its hyper-spectral data contain much more information about atmospheric constituents. We have developed advanced techniques to achieve sensitive measurements of tropospheric pollutants, SO₂ and NO₂, from OMPS-NM observations.

Direct Vertical Column Fitting (DVCF) Algorithm for SO₂ and NO₂ Retrievals

$$\ln I_m(\lambda) - \ln I_{TOA}(\lambda) = V \int_0^{\infty} \frac{\partial \ln I_{TOA}}{\partial \tau_z} S_z \sigma(\lambda) dz - \sum_i \xi_i \sigma(\lambda, T_i) + (\Delta R + c_1(\lambda - \lambda_0)) \frac{\partial \ln I_{TOA}}{\partial R}$$

- λ : wavelength
- I_m : measured radiance
- I_{TOA} : radiative transfer simulation
- σ : trace gas absorption cross sections
- R : Surface reflectivity or cloud fraction
- SO₂ or NO₂ vertical column : V
- SO₂ or NO₂ Shape factor : S_z
- Other absorber slant column : ξ_i
- Aerosol Index : c_1
- Altitude-resolved Air Mass Factor : $- \frac{\partial \ln I_{TOA}}{\partial \tau_z}$

Spectral range used for S-NPP/OMPS

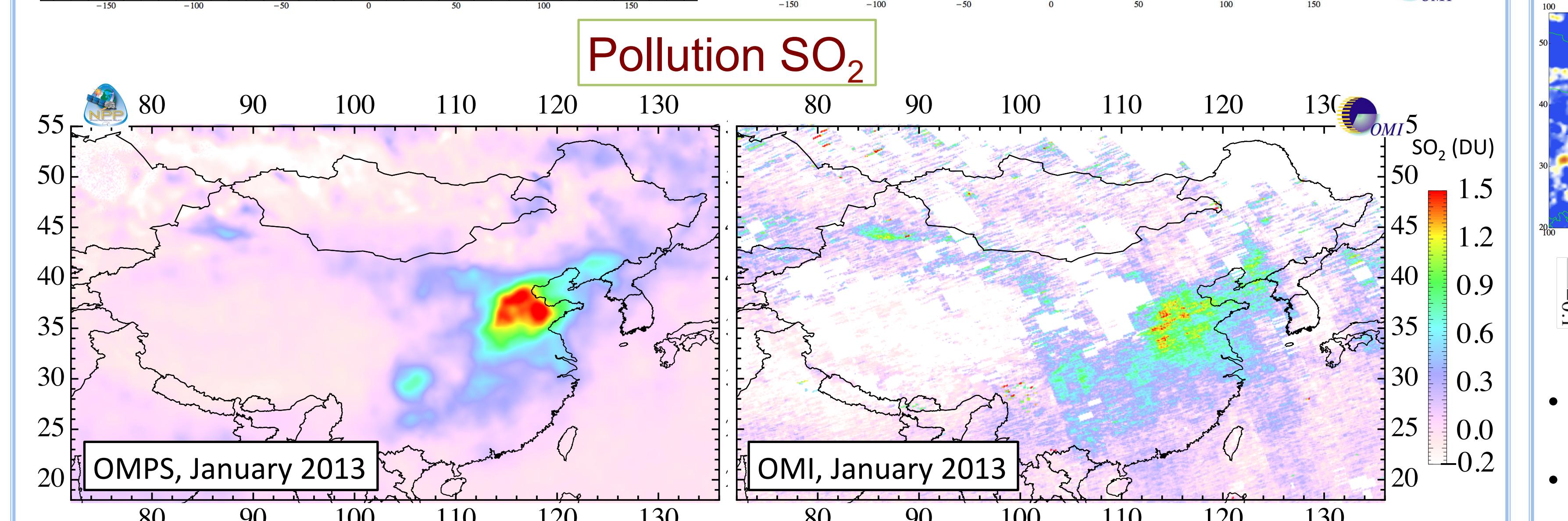
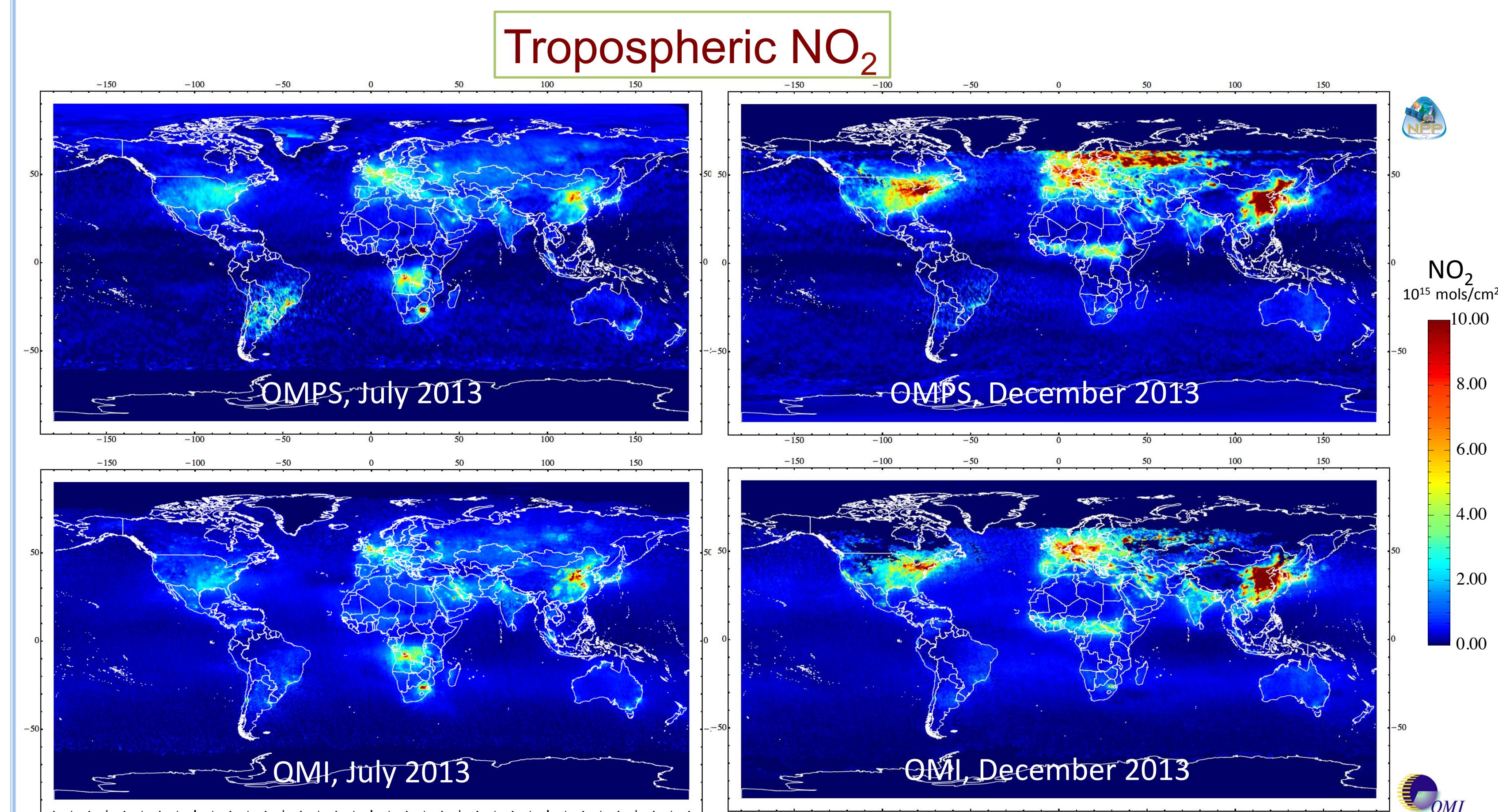
SO₂ Retrieval: 308 – 360 nm
SO₂/O₃ : 308 – 333 nm , albedo, pressures, cloud fraction, aerosol index : 333 – 360 nm

NO₂ Retrieval: 345 – 378 nm
NO₂: 345 – 378 nm , albedo, pressures, cloud fraction, aerosol index: 350 – 378 nm
Orbit-based strat-trop separation

Aerosol Index (AI)

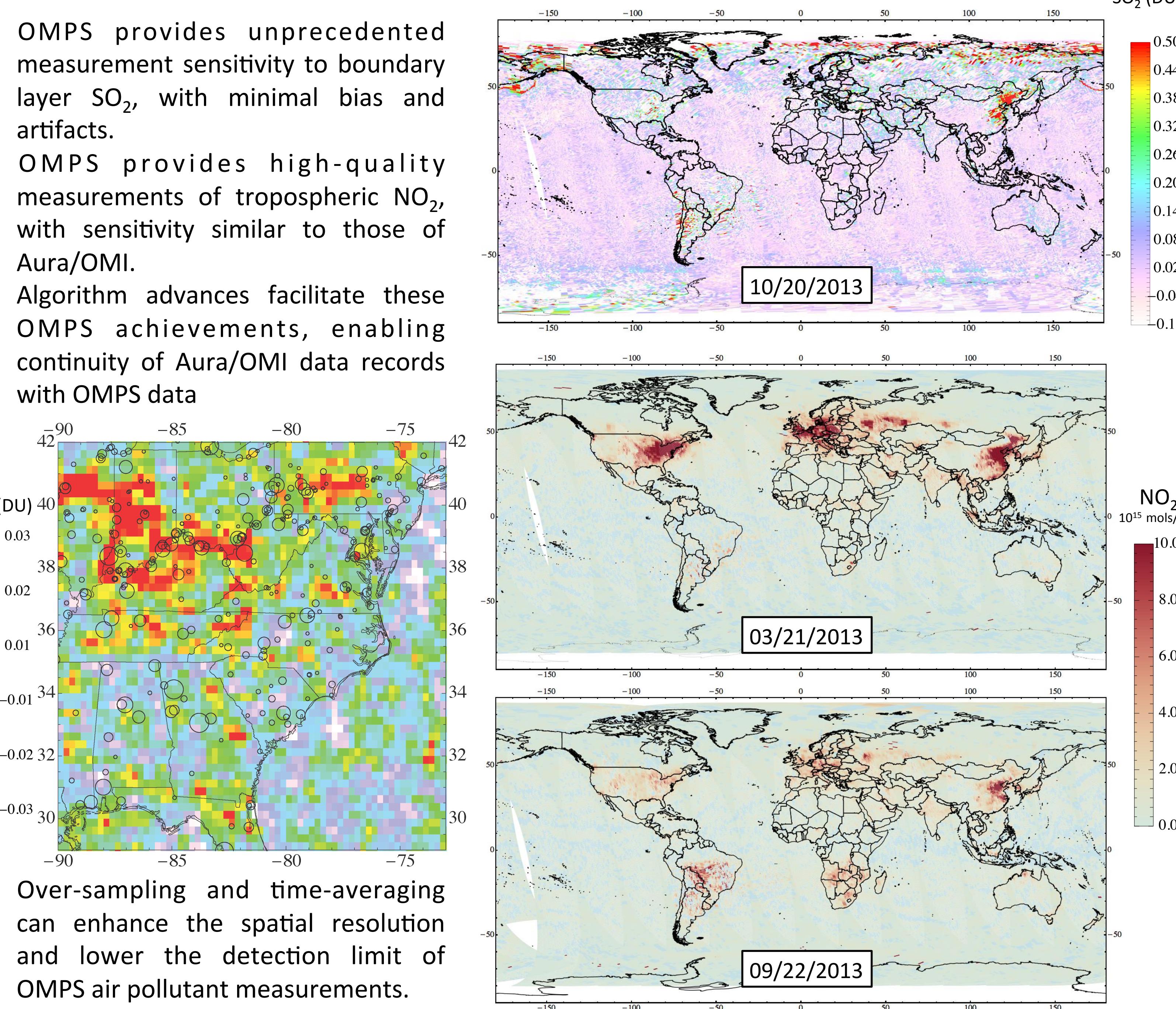
Positive AI indicates the presence of UV absorbing aerosols, such as dust, smoke, and volcanic ash. Negative AI associates with clouds and non-absorbing aerosols (such as sulfate).

Monthly Mean Comparisons: SNPP/OMPS-NM vs. Aura/OMI



OMPS Provides Daily Global Observations of Air Pollutants: SO₂ and NO₂

- OMPS provides unprecedented measurement sensitivity to boundary layer SO₂, with minimal bias and artifacts.
- OMPS provides high-quality measurements of tropospheric NO₂, with sensitivity similar to those of Aura/OMI.
- Algorithm advances facilitate these OMPS achievements, enabling continuity of Aura/OMI data records with OMPS data
- Over-sampling and time-averaging can enhance the spatial resolution and lower the detection limit of OMPS air pollutant measurements.



Example Air Quality Application: Quantification of Pollution Episodes October 18 – 24, 2013, Northeastern China

- OMPS NM measurements can be used to make state-of-the-art SO₂, NO₂ and Aerosol maps for air quality and hazard applications.
- These products will become even more valuable as the OMPS capabilities to make higher spatial resolution measurements are realized.